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Applicant: KOYAMA et al

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Title: MOLD FOR CASTING AND METHOD OF SURFACE TREATMENT THEREOF

DECLARATION UNDER 37 CFR 1.132

I, Hiroaki KOYAMA, an Inventor of the above-identified application, hereby declare as follows:

1. I have been engaged for 22 years in the design, manufacture and testing of casting dies of the type disclosed and claimed in the above identified application, and I am employed by Honda Engineering Co., Ltd., a corporation, whose primary business is the manufacturing and selling of automobiles.

2. I am considered to be an expert in the field of mold or die production. I have a degree in machine engineering from Meiji University in Japan.

3. I am familiar with and have knowledge of the above-identified patent application assigned to Honda Motor Co., Ltd., and based on Japanese application No. 2002-316632.

4. I am aware of the claimed subject matter of the above-identified application and the methods and materials discussed therein, including the claims 6, 10, 14 and 16-22.

5. Tests were conducted in comparison of the subject matter presently claimed in the above–identified application and the prior art, specifically Japanese Publication 2002-060845 (hereinafter JP '845).

6. JP 845 relates to a casting die adapted for the prolonged service life. This differs from the instant invention in that the instant claims are directed to the characteristics that the maximum height of roughness of a casting die is not more than 8 μm and the compressive residual stress is larger than 1200 MPa after two times of shot peening treatments each performed for a time period ranging from 5 seconds to 10 seconds.

7. "Shot peening" is a cold working process in which small spherical media called shot bombard the surface of a part. During the shot peening process, each piece of shot that strikes the material acts as a tiny peening hammer, imparting to the surface a small indentation or dimple. To create the dimple, the surface of the material must yield in tension. Below the surface, the material tries to restore its original shape, thereby producing below the dimple, a hemisphere of cold-worked material highly stressed in compression. Because the overlapping dimples from shot peening create a uniform layer of compressive stress at metal surfaces, shot peening provides considerable increases in part life.

8. With respect to independent claims 6 and 17, the first (coarse) shot peening treatment is applied to a cavity surface of the casting die for a time period ranging from 5 seconds to 10 seconds, so that the maximum height of roughness of the casting dies is not more than 16 mm, and a compressive residual stress of the casting die is 1000 MPa or larger after the first shot peening and before sulphonitriding treatment, and then the second (finishing) shot peening treatment is applied to the cavity surface for a time period ranging from 5 seconds to 10 seconds, so that the maximum height of roughness of the cavity surface is not more than 8 μm, and the compressive residual stress is larger than 1200 MPa after the second shot peening treatment.

9. In the field of surface treatment, research is conducted to improve the useful life of metal products such as casting dies, and shows that shot peening prolongs the useful life. Therefore, the shot peening is widely used as surface treatment for prolonging the service life of metal products. However, after a shot peening treatment, a small surface roughness of not more than 8 μm would not obtained usually. Rather, a surface roughness significantly larger than 8 μm has a conventionally recognized benefit. For a casting die, a surface roughness (maximum height) of approximately 50 μm is enough to obtain a better surface quality for the cast article. Therefore, those of ordinary skill in the art would try to make the surface roughness approximately 50 μm after the shot peening treatment, and not try to obtain a surface roughness of a smaller value. Nevertheless, we found that the die cavity surface should be maintained as smooth as possible to increase a heat transfer rate between the cast metal and the die surface and also to obtain a better surface quality for the cast article. For this purpose, we intentionally made the surface roughness not more than 8 μm by setting the shot peening time for a period in a range of 5 to 10 seconds in each of the first and second shot peening treatments. The shot peening treatment for such a reduced duration is not obvious from the prior art.

10. Experiments were conducted under the conditions in accordance with claims 6 and 17 of the above-identified patent application (TEST A), and the conditions disclosed in JP 845 (TEST B), with respect to the cavity surface of the casting die made of a steel

material. Specifically, in TESTS A and B, Carborundum™ (ceramic particles) with a diameter of 220 mesh (average particle size of 50 μm) were used in the first shot peening, and glass beads with a diameter of 220 mesh (average particle size of 50 μm) were used in the second shot peening. In TEST A, a steady stream of Carborundum™ was projected for 10 seconds by injection pressure of 0.49 MPa in the first shot peening, and a steady stream of the glass beads was projected for 10 seconds by injection pressure of 0.49 MPa in the second shot peening. The resultant surface roughness of the cavity surface evaluated after the second shot peening was 8 μm. In TEST B, a steady stream of Carborundum™ was projected for 60 seconds by injection pressure of 0.3 MPa in the first shot peening, and a steady stream of the glass beads was projected for 60 seconds by injection pressure of 0.4 MPa in the second shot peening, as disclosed in JP 845. The resultant surface roughness of the cavity surface evaluated after the second shot peening was 61 μm. The conditions and the results are shown in the table below.

TEST	First shot peening				Second shot peening				Ry (μm)
	Particle	Particle Size	Injection pressure (MPa)	Shot time (s)	Particle	Particle Size	Injection pressure (MPa)	Shot time (s)	
A	Carborundum™ (ceramic)	220 mesh	0.49	10	Glass	220 mesh	0.49	10	8
B	Carborundum™ (ceramic)	220 mesh	0.3	60	Glass	220 mesh	0.4	60	61

The test results demonstrate that the surface roughness Ry (maximum height) varies as the shot time is extended from 10 seconds to 60 seconds, and largely exceeds 8 μm up to 61 μm.

11. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 21 January 2009

Hiroaki Koyama.

Hiroaki KOYAMA
(inventor signature)